

AD

AD-E403 278

Technical Report ARESI-TR-09001

## **POLYAM/POLYCOAT CERTIFICATION PROGRAM**

Adam M. Skrzypczak

June 2010

U.S. ARMY ARMAMENT RESEARCH, DEVELOPMENT AND  
ENGINEERING CENTER

Enterprise and Systems Integration Center

Picatinny Arsenal, New Jersey



Approved for public release; distribution is unlimited.

The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other documentation.

The citation in this report of the names of commercial firms or commercially available products or services does not constitute official endorsement by or approval of the U.S. Government.

Destroy this report when no longer needed by any method that will prevent disclosure of its contents or reconstruction of the document. Do not return to the originator.

## REPORT DOCUMENTATION PAGE

Form Approved  
OMB No. 0704-01-0188

The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden to Department of Defense, Washington Headquarters Services Directorate for Information Operations and Reports (0704-0188), 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.  
PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ADDRESS.

1. REPORT DATE (DD-MM-YYYY) June 2010	2. REPORT TYPE Final	3. DATES COVERED (From - To) June 2007 to October 2009		
4. TITLE AND SUBTITLE  POLYLAM/POLYCOAT CERTIFICATION PROGRAM		5a. CONTRACT NUMBER		
		5b. GRANT NUMBER		
		5c. PROGRAM ELEMENT NUMBER		
6. AUTHORS  Adam M. Skrzypczak		5d. PROJECT NUMBER		
		5e. TASK NUMBER		
		5f. WORK UNIT NUMBER		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army ARDEC, ESIC Logistics Research and Engineering Directorate (RDAR-EIL-P) Picatinny Arsenal, NJ 07806-5000		8. PERFORMING ORGANIZATION REPORT NUMBER		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army ARDEC, ESIC Knowledge & Process Management (RDAR-EIK) Picatinny Arsenal, NJ 07806-5000		10. SPONSOR/MONITOR'S ACRONYM(S)		
		11. SPONSOR/MONITOR'S REPORT NUMBER(S) Technical Report ARESI-TR-09001		
12. DISTRIBUTION/AVAILABILITY STATEMENT  Approved for public release; distribution is unlimited.				
13. SUPPLEMENTARY NOTES				
14. ABSTRACT  The polylam/polycoat certification program was developed to eliminate a sole-source vendor by researching, testing, and approving alternative manufacturers for these materials. Concurrently, existing specifications and requirements were analyzed and improved to promote quality and competitiveness in awarding future contracts.				
15. SUBJECT TERMS Fiber tube      Polylam      Polycoat      Packaging      Mortars      60 mm,      81 mm 120 mm,      Hand grenades				
16. SECURITY CLASSIFICATION OF: a. REPORT U		17. LIMITATION OF ABSTRACT SAR	18. NUMBER OF PAGES 11	19a. NAME OF RESPONSIBLE PERSON Adam M. Skrzypczak 19b. TELEPHONE NUMBER (Include area code) (973) 724-4926

20100623237

15. SUBJECT TERMS Fiber tube      Polylam      Polycoat      Packaging      Mortars      60 mm,      81 mm 120 mm,      Hand grenades				
16. SECURITY CLASSIFICATION OF: a. REPORT U		17. LIMITATION OF ABSTRACT SAR	18. NUMBER OF PAGES 11	19a. NAME OF RESPONSIBLE PERSON Adam M. Skrzypczak 19b. TELEPHONE NUMBER (Include area code) (973) 724-4926

## CONTENTS

	Page
Introduction	1
Methods, Assumptions, and Procedures	1
Suppliers	1
Independent Evaluator	1
Results and Discussion	2
Conclusions and Recommendations	5
WVTR Requirement	5
Basis Weight Requirement	5
Distribution List	7

## INTRODUCTION

The objective of the Alternative Polylam/Polycoat Qualification Program was to evaluate alternative suppliers in an effort to eliminate a potential single point failure in fiber containers used for ammunition packaging (for the 60, 81, and 120-mm mortar cartridges and M67 hand grenades). The impetus behind the elimination of a sole-source supplier is simply to lower cost, minimize risk, and improve quality by fostering competition between multiple suppliers. It is the goal of this program to analyze both manufacturers and the specifications outlined in drawing 12977500 to ensure that the Warfighter receives the highest quality product for the lowest price.

## METHODS, ASSUMPTIONS, AND PROCEDURES

In order to complete this objective, potential alternative suppliers (as well as the sole source supplier) were contacted to provide samples developed in accordance to requirements found in drawing 12977500. The samples from the manufacturers were then sent to an independent laboratory for testing. The focus of the testing was concentrated on the inner material (polylam) and outer material (polycoat). Mechanical properties such as tensile strength, tear strength, and Mullen burst strength were performed on both inner and outer tube materials. Basis weight (per mil) and bursting strength (per mil) were additionally performed on the polylam inner layer materials. Coefficient of friction (COF) and water vapor transmission rate (WVTR) were additionally performed on the polycoat outer tube material. Two rounds of tests were performed, with results being provided to the manufacturers to inform them of any deficiencies in need of correcting.

### Suppliers

Fortifiber Corporation (qualified supplier)

Jen-Coat Inc.

Covalence Coated Products

### Independent Evaluator

All material specifications and testing methods for this program can be found in DTL 1297750, "Construction Details for Container, Ammunition, Fiber, Polyethylene Laminated, Spirally Wound for Mortar Cartridges and Hand Grenades."

### Material Specifications

Polylam material: 40 lb Natural Kraft/14 lb low density polyethylene (LDPE)/70 lb Natural Kraft

Polycoat material: 70 lb Natural Kraft/20 lb black Polyolefin

### Testing Specifications

Tear strength [cross direction (CD) and machined direction (MD)]: TAPPI T414 (at least 10 specimens per direction)

Tensile strength (CD and MD): TAPP1494 (at least 10 specimens per direction)

Mullen burst strength: TAPP T403 (at least five specimens "face up" and at least five specimens "face down")

COF (poly to poly): ASTM D1894 (test at least five specimens)

WVTR: TAPPI T523 (test at least two specimens and average the results together for each sample)

Basis weight: TAPPI T410 (at least six specimens per sample)

Bursting strength: TAPPI T810 (at least five specimens "face up" and at least five specimens "face down")

It should be noted that the specifications used for both material construction and testing were developed with input from the current qualified supplier. The performance requirements are considered to be of more importance than the material specifications for the purposes of this program as long as basis weight is met.

## RESULTS AND DISCUSSION

Two rounds of testing were conducted on samples from the participating suppliers. The first round was completed in July 2008, with the second round being completed in April 2009. The results of the first test were sent to the suppliers with some recommendations on how to improve their materials. Due to time and cost restraints, the second test was the final round that had to be met in order to become a qualified supplier.

The results of the first round of testing can be seen in table 1 (polycoat) and table 2 (polylam). As can be seen in table 1, all three participants had deficiencies in various categories in regards to their polycoat materials: Fortifiber missed WVTR, Jen-Coat missed both WVTR and CD - tear strength, and Covalence missed kinetic coefficient (CoE). Table 2 shows the test results for the polylam materials. It should be noted that certain tests were not performed (tensile strength and tear strength) in the first round. Fortifiber also did not submit specimens for testing. However, both Jen-Coat and Covalence passed all other requirements in the first round of testing for polylam.

Following the first round of tests, the suppliers were given time to improve their material designs in order to improve in areas where they were found to be deficient. Improved samples of both polylam and polycoat were again requested. It should be noted that all three manufacturers simply sent additional samples of the polylam material used in the first round as they had no need to improve or change the formulation following the first round of tests. Tests for the polycoat specimens remained the same, while tests for polylam specimens were expanded to include the previously omitted tear strength and tensile strength tests. The results of the tests can be seen in table 3 (polycoat) and table 4 (polylam).

As can be seen in table 3, manufacturer Fortifiber passed all given requirements. Jen-Coat passed the previously failed CD-tear strength test, but again failed the WVTR requirement. The Covalence test results were far more curious as they resolved deficiencies in one category (CoE-kinetic), while showing new deficiencies in others: MD - tear strength and WVTR. It is believed that they switched from polypropylene to polyethylene for use as their polyolefin material, which may explain the deficiencies.

Table 1  
Polycoat test results from first round of testing

	Fortifiber	Jen-Coat	Covalence	DTL12977500 requirement	Test method
Tensile strength (lb/in.)					
(MD)	62.00	53.00	73.00	≥41	TAPPI T494
(CD)	28.00	32.00	33.00	≥23	
Tear strength (g)					
(MD)	184.00	146.00	155.00	≥144	TAPPI T414
(CD)	208.00	149.00	180.00	≥161	
Mullen burst strength (psi)	80.00	72.00	96.00	≥50	TAPPI T403
Coefficient of friction					
(static)	0.47	0.50	0.25		
(kinetic)	0.35	0.48	0.20	≥0.29	ASTM D1894
WVTR @ 73°F/50% RH (g/m <sup>2</sup> /24 hrs)	1.80	1.77	1.34	≤1.76	TAAPPI T523
Thickness (mil)	8.20	7.50	5.00	n/a	TAPPI T411

Table 2  
Polylam test results from first round of testing

	Fortifiber	Jen-Coat	Covalence	DTL12977500 requirement	Test method
Thickness (mils)	n/a	10.00	10.00	n/a	TAPPI T411
Basis weight (g/cm <sup>2</sup> )	n/a	0.0197	0.0197	n/a	TAPPI T410
Mullen burst strength (psi)	n/a	138.30	140.70	≥99	TAPPI T403
Basis weight per mil (lb/1 mil thickness/100 ft <sup>2</sup> )	n/a	4.00	4.00	≥3	n/a
Burst strength per mil (psi/1 mil thickness)	n/a	13.80	14.10	≥2	TAAPPI T810

Table 3  
Polycoat test results from second round of testing

	Fortifiber	Jen-Coat	Covalence	DTL12977500 requirement	Test method
Tensile strength (lb/in.)					
(MD)	63.00	75.00	68.00	≥41	TAPPI T494
(CD)	33.00	48.00	30.00	≥23	
Tear strength (g)					
(MD)	170.00	174.00	129.00	≥144	TAPPI T414
(CD)	230.00	198.00	179.00	≥161	
Mullen burst strength (psi)	95.00	89.00	86.00	≥50	TAPPI T403
Coefficient of friction					
(static)	0.51	0.47	0.39		
(kinetic)	0.35	0.45	0.30	≥0.29	ASTM D1894
WVTR @ 73°F/50% RH (g/m <sup>2</sup> /24 hrs)	1.43 ±0.29	2.08 ±0.15	2.42 ±0.11	≤1.76	TAAPPI T523
Thickness (mil)	8.00	8.20	7.20	n/a	TAPPI T411

Table 4  
Polylam test results from second round of testing

	Fortifiber	Jen-Coat	Covalence	DTL12977500 requirement	Test method
Thickness (mils)	8.00	8.20	7.20	n/a	TAPPI T411
Basis weight (g/cm <sup>2</sup> )	0.02	0.0199	0.0197	n/a	TAPPI T410
Mullen burst strength (psi)	136.00	151.00	140.00	≥99	TAPPI T403
Basis weight per mil (lb/1 mil thickness/100 ft <sup>2</sup> )	4.10	4.00	3.90	≥3	n/a
Burst strength per mil (psi/1 mil thickness)	12.00	15.00	14.00	≥2	TAAPPI T810
Tensile strength (lb/in.)					
(MD)	96.00	111.00	90.00	≥77	TAPPI T494
(CD)	56.00	54.00	52.00	≥36	
Tear strength (g)					
(MD)	282.00	224.00	238.00	≥221	TAPPI T414
(CD)	334.0	280.00	306.00	≥234	

## CONCLUSIONS AND RECOMMENDATIONS

As discussed in the previous section, the results of the second round of laboratory testing show that manufacturer Fortifiber Corp (the current supplier) was the only one to have passed both tests for polylam and polycoat. Jen-Coat came closest to meeting the polycoat requirements by only failing to meet the water vapor transmission rate (WVTR) requirement. Covalence had the poorest showing after doing worse during the second round of tests. All three manufacturers met requirements to produce polylam materials.

It is the finding of this program that there is a need to adjust the requirements set out in drawing 12977500 in order to qualify all three suppliers. The requirements, as they are currently established, were developed with input from the qualified supplier Fortifiber Corp to conform to material they had producing for Government contracts. Therefore, the specification was not developed using empirical needs based on a given requirement, but rather using manufacturer provided data based on their production capabilities. Thus, it is the recommendation of this office that the requirement values be changed to allow a range of acceptable values to accommodate material produced from alternate manufacturers. The requirements recommended to be adjusted are WVTR and basis weight of paper; as follows:

### Water Vapor Transmission Rate Requirement

The WVTR would be changed from the current value of  $\leq 1.76$  to  $\leq 2.48 \text{ g/m}^2/24 \text{ hrs}$ . This was done because the current requirement was deemed too restrictive without providing an improvement on performance. Originally, when these materials came into use in fiber tubes, the requirement was  $3.2 \text{ g/m}^2/24 \text{ hrs}$ . The  $2.48 \text{ g/m}^2/24 \text{ hrs}$  was selected as it provides the desired performance without being overly restrictive and inhibiting producability of the material.

### Basis Weight Requirement

Evidence has shown that the original supplier, Fortifiber, has not been producing polylam/polycoat materials to their own established requirements. Testing shows that they have been producing polylam 70 lb Natural Kraft/28 lb low density polyethylene (LDPE)/40 lb Natural Kraft; doubling the amount of LDPE from the specified 14 lb paper weight. Furthermore, they have been producing the polycoat at 70 lb Natural Kraft/29 lb black polyolefin, which has increased the weight of polyolefin from the specified 20 lb weight. It is believed that producing these materials with the increased weights has given Fortifiber an unfair advantage over potential competitors. It is the recommendation of this office to make the new basis requirements as follows:

- Polycoat -  $79 \pm 1 \text{ lb Natural Kraft Paper}/25 \pm 5 \text{ black polypropylene}$
- Polylam -  $42.5 \pm 2.5 \text{ lb Natural Kraft paper}/21 \pm 7 \text{ lb LDPE}/72.5 \pm 2.5 \text{ lb Natural Kraft paper}$

By allowing for a range of values, the manufacturers of these materials can determine which paper weights to use to meet the performance requirements.

In conclusion, if all three changes are implemented, then two suppliers (Fortifiber and Jen-Coat) would be allowed to qualify as sources for both polylam and polycoat materials. Covalence would be qualified as a supplier for polylam only.

## DISTRIBUTION LIST

U.S. Army ARDEC  
ATTN: RDAR-EIK  
RDAR-GC  
RDAR-EIL-P (6)  
Picatinny Arsenal, NJ 07806-5000

Defense Technical Information Center (DTIC)  
ATTN: Accessions Division  
8725 John J. Kingman Road, Ste 0944  
Fort Belvoir, VA 22060-6218

Commander  
Soldier and Biological/Chemical Command  
ATTN: AMSSB-CII, Library  
Aberdeen Proving Ground, MD 21010-5423

Director  
U.S. Army Research Laboratory  
ATTN: AMSRL-CI-LP, Technical Library  
Bldg. 4600  
Aberdeen Proving Ground, MD 21005-5066

Chief  
Benet Weapons Laboratory, WSEC  
U.S. Army Research, Development and Engineering Command  
Armament Research, Development and Engineering Center  
ATTN: RDAR-WSB  
Watervliet, NY 12189-5000

Director  
U.S. Army TRADOC Analysis Center-WSMR  
ATTN: ATRC-WSS-R  
White Sands Missile Range, NM 88002

Chemical Propulsion Information Agency  
ATTN: Accessions  
10630 Little Patuxent Parkway, Suite 202  
Columbia, MD 21044-3204

GIDEP Operations Center  
P.O. Box 8000  
Corona, CA 91718-8000